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A research study was initiated to (1) identify and compare the effectiveness of alternative learning strategies upon learner performance, (2) incorporate effective strategies and interactive practice materials within a systematic training program, and (3) empirically validate the perfcrmance of strategies-trained and untrained students. To determine if the effectiveness of strategy training is influenced by the sequence of instruction, the participants in the learning-strategies class were randomly assigned to two groups. One group received primary strategy training during the first half of the semester and support training during the second half. The other group received the opposite instructional sequence. A control group was recruited from general psychology classes. Some of the strategies included were various mnemonic devices, imagery elaboration, paraphrasing, visual networking, goal-setting distraction desensitization, and formal peer interaction. Among the findings was that strategies-trained students achieved 17 percent to 40 percent more on technical-subject-matter achievement tests than did untrained students. Low-reading-aptitude students achieved more under imagery strategies than low-reading-aptitude controls under the paraphrasing of the untrained strategies condition. Visual-networking-strategies students scored 26 percent higher on delayed-retention achievement tests than controls in the untrained group. (LRA)

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AIR FORCE HUMAN RESOURCES LABORATORY

VALIDITY OF LEARNING STRATEGIES/SKILLS TRAINING

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This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

MARTY R. ROCKWAY, Technical Director
Technical Training Division

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Research has documented that most students tend to employ inefficient or less-than-effective methods for acquiring, retaining, retrieving, or applying information. To acquire, retain, and appropriately apply knowledge, it has become evident that methods designed to organize information for presentation to learners are of beneficial, yet limited, effectiveness. In contrast, strategies which the learner finds useful in transforming information through personal effort are likely to be "owned," retained, and contribute to increased performance. Programmatic research was initiated to (a) identify and compare the effectiveness of alternative learning strategies upon learner performance, (b) incorporate effective strategies and interactive practice materials within a systematic training program, and (c) empirically validate the performance of strategies-

trained and untrained students. Some of the strategies included have been (a) various mnemonic devices, (b) imagery elaboration, (c) paraphrasing, (d) visual networking, (e) goal-setting, (f) distraction desensitization, and (g) formal peer interaction.

Strategies-trained students achieved 17% to 40% more on technical subject-matter achievement tests than did untrained students. Low reading aptitude students achieved more under imagery strategies than low reading aptitude controls under the paraphrasing or the untrained strategies condition. Visual networking strategies students scored 26% higher on delayed retention achievement tests than controls in the untrained group. In most cases, high reading aptitude students achieved more than lower reading aptitude students.

Preface

This is the third year and final report of Project ARPA #3204. This project has involved the development and assessment of a cognitively based learning strategy system. Dr. Gerard Deignan, Air Force Human Research Laboratory at Lowry Air Force Base, was the Project Scientist and Drs. Harold O'Neil and Dexter Fletcher, Advanced Research Projects Agency, were the Program Managers. All three of these individuals made extremely valuable contributions to the conduct of this research and development effort.

In addition, we wish to acknowledge the efforts and cooperation of those Texas Christian University faculty members and ROTC personnel who assisted us in obtaining experimental participants and who assisted in the selection of text material for program evaluation.

The work reported in this document was conducted under the provisions of Contract Number MDA 903-76-C0218 with Texas Christian University, Fort Worth, Texas 76129. Dr. Donald F. Dansereau was the Principal Investigator. This research is based upon previous work reported by the contractor under Contract F41609-74-C-0013 in AFHRL-TR-75-41, Effective Learning Strategy Training Program: Development and Assessment.

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I. Introduction

A. Purposes

The overall goal of this project has been to develop a learning strategy training program that will help technical trainees acquire and use information more effectively. An important, anticipated by-product of this improved effectiveness will be a reduction in training costs arising from reduced training time within long-term courses or course series, and a reduction in the amount of retraining or field training necessary for successful job performance.

Over the past 3½ years we have developed, evaluated, and modified components of an interactive learning strategy system (Dansereau, 1978; Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a; Dansereau, McDonald, Collins, Garland, Holley, Diekhoff, & Evans, 1979b; Holley, Dansereau, McDonald, Garland, & Collins, 1979; Collins, Dansereau, Holley, Garland, & McDonald, 1979). Evaluations of this system indicate success in improving the participants' learning behaviors, attitudes, and a 30% to 40% increase in performance compared to untrained participants using their own methods. In these previous studies, concerted attempts have been made to amass diagnostic data upon which to base further modifications of the strategy system and the training program. Before overviewing the recent studies that have been conducted, a brief description of the learning strategy program will be presented.

B. Description of the Strategy System

A detailed description of the system is beyong the scope of this report; the various portions of the system have been presented in a number of other technical reports and publications (Dansereau, Actkinson, Long, & McDonald, 1974; Dansereau, Collins, McDonald, Garland, Holley, Evans, & Diekhoff, 1978; Dansereau, Long, McDonald, & Actkinson, 1975a; Dansereau, Long, McDonald, Actkinson, Ellis, Collins, Williams, & Evans, 1975b; Dansereau, Long, McDonald, Actkinson, Collins, Evans, Ellis, & Williams, 1975c; Dansereau, Long, McDonald, Actkinson, Collins, Evans, Ellis, & Williams, 1975d; Dansereau, Long, McDonald, Actkinson, Collins, Evans, Ellis, & Williams, 1975e; Dansereau et al., 1979b), and the reader is referred to these documents for further information.

The general approach to the development of the strategy system has been strongly influenced by the fact that effective interaction with technical material requires that the student actively engage in a complex system of interrelated activities. To assist the student in this endeavor, a set of mutually supportive strategies has been created. This set

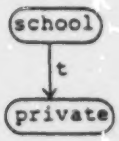
can be divided into "primary" strategies which are used to operate on the material directly and "support" strategies which are used to help the learner to maintain a suitable cognitive climate. The primary set includes strategies for acquiring and storing the information and strategies for subsequently outputting and using the stored information. Networking forms the basis for these primary strategies. During acquisition the student identifies important concepts or ideas in the material and represents their interrelationships in the form of a network map. To assist the student in this endeavor s/he is taught a set of named links that can be used to code the relationships between ideas. The networking processes emphasize the identification and representation of (a) hierarchies (type/part), (b) chains (lines of reasoning/temporal orderings/causal sequences), and (c) clusters (characteristics/definitions/analogies). Figure 1 is a schematic representation of these three types of structures and their associated links and Figure 2 is an example of a summary map of a nursing textbook chapter. Application of this technique results in the production of structured two-dimensional maps. These cognitive networks provide the student with a spatial organization of the information contained in the original training materials. While constructing the map, the student is encouraged to paraphrase and/or draw pictorial representations of the important ideas and concepts for inclusion in the network.

When faced with a test or a task in which the learned information is to be used, the student is trained to use the named links as retrieval cues and the networking process as a method for organizing the material prior to responding. Assessments of networking (Holley et al., 1979; Dansereau et al., 1979b) have shown that students using this strategy perform significantly better on text processing tasks than do students using their own methods.

The major component of the support strategies is concentration management. This component, which is designed to help the student set and maintain constructive moods for studying and task performance, consists of a combination of elements from systematic desensitization (Jacobsen, 1938; Wolpe, 1969), rational behavior therapy (Ellis, 1963, Maultsby, 1971), and therapies based on positive self-talk (Meichenbaum & Goodman, 1971; Meichenbaum & Turk, 1975). The students are first given experiences and strategies designed to assist them in becoming aware of the negative and positive emotions, self-talk, and images they generate in facing a learning task. They are then instructed to evaluate the constructiveness of their internal dialogue and are given heuristics for making appropriate modifications.

In preparing for studying or testing sessions students

HIERARCHY STRUCTURES

Part (of) Link	The content in a lower node is part of the object, process, idea or concept contained in a higher node.	Key Words is a part of is a segment of is a portion of
Type (of)/ Example (of) Link 	The content in a lower node is a member or example of the class or category of processes, ideas, concepts, or objects contained in a higher node.	Key Words is a type of is in the category is an example of is a kind of Three procedures are

CHAIN STRUCTURES

Leads to Link	The object, process, idea, or concept in one node leads to or results in the object, process, idea, or concept in another node.	Key Words leads to results in causes is a tool of produces

CLUSTER STRUCTURES

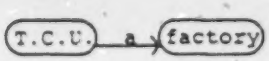
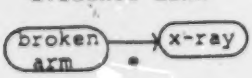
Analogy Link 	The object, idea, process, or concept in one node is analogous to, similar to, corresponds to, or is like the object, idea, process, or concept in another node.	Key Words is similar to is analogous to is like corresponds to
Characteristic Link	The object, idea, process, or concept in one node is a trait, aspect, quality, feature, attribute, detail, or characteristic of the object, idea, process, or concept in another node.	Key Words has is characterized by feature is property is trait is aspect is attribute is
Evidence Link 	The object, idea, process, or concept in one node provides evidence, facts, data, support, proof, documentation, confirmation for the object, idea, process or concept in another node.	Key Words indicates illustrated by demonstrated by supports documents is proof of confirms

Figure 1: Link types and structure types

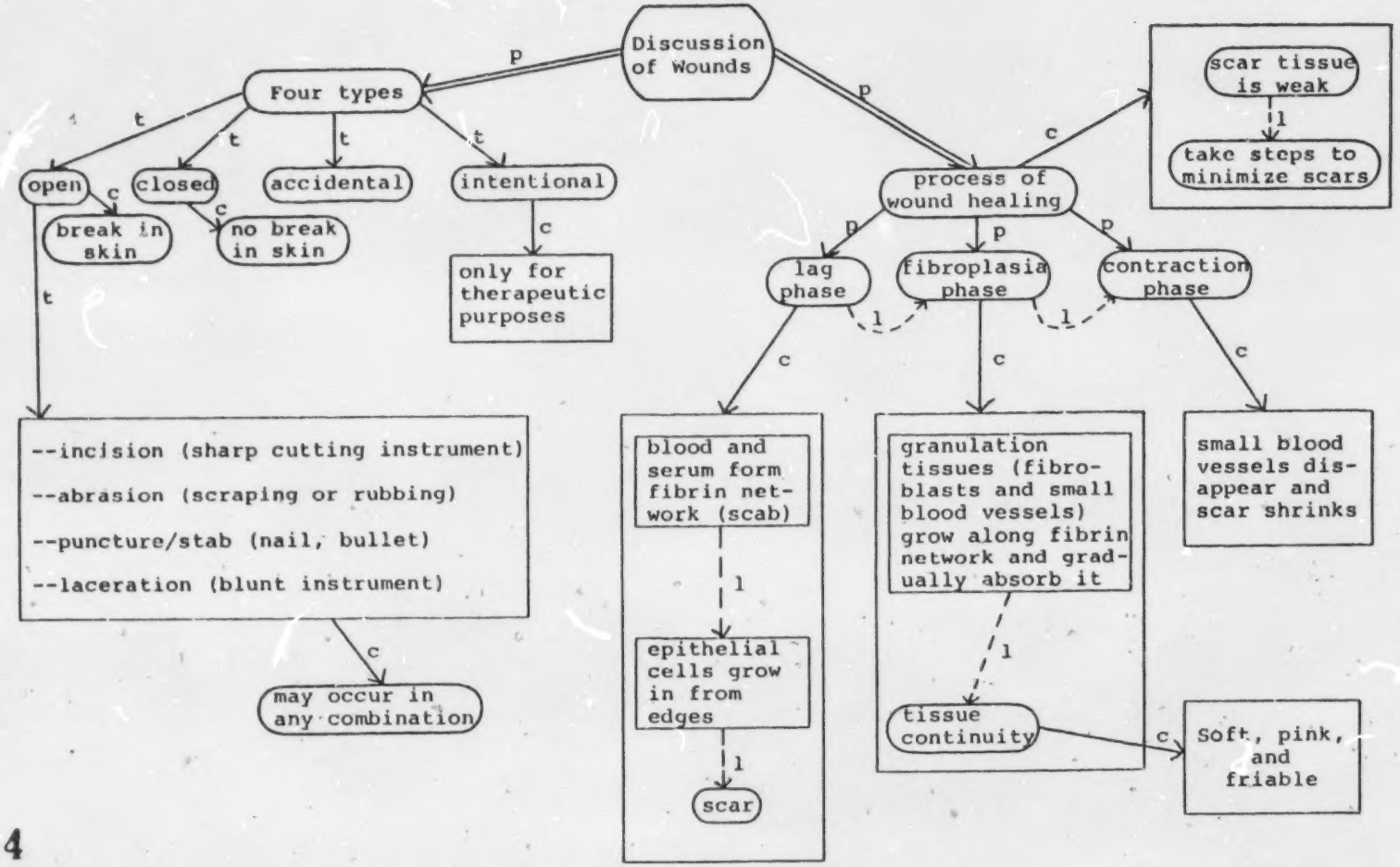


Figure 2: Example of a network of a chapter from a nursing textbook.

report that they usually spend little or no conscious effort establishing constructive moods. To remedy this situation the student is trained on a technique that forms the basis of systematic desensitization: imagination of the target situation during relaxation. More specifically, the students are instructed to spend 2 to 3 minutes relaxing and then imagining their actions as they proceed through a productive study or test session. To help them maintain the resulting mood they are given experiences and techniques to assist them in determining when, how, and why they get distracted, the duration of their distraction periods, and their typical reactions to distraction. They are then trained to cope with distractions by using relaxation and positive self-talk and imagery to reestablish an appropriate learning state.

This particular combination of concentration management strategies has been shown to lead to significantly better performance on text processing tasks in comparison to students using their own methods (Collins et al., 1979). These strategies have been supplemented by training on goal-setting, scheduling, and monitoring (see Dansereau et al., 1978), to form the support strategy component of the program.

C. Overview of Recent Studies

The major study to be presented in this report consisted of an evaluation of a modified version of the overall learning strategy training program. This program was a condensed version of the one implemented January, 1977 (Dansereau et al., 1979a). The modifications were based on the results of independent evaluations of the primary (Holley et al., 1979) and support (Collins et al., 1979) strategies and were designed to reduce the total training time to approximately 15 hours.

Although it was hoped that this program could be implemented in a military technical training context, examination of the available possibilities indicated that such implementation was not feasible at the scheduled time of the evaluation. Consequently, the program was implemented as part of the regular curriculum at Texas Christian University. To maximize the possibility of subsequent transfer to military training, every effort was made to attract program participants who were similar in aptitudes and interests to technical trainees (e.g., with respect to the Delta Vocabulary test the means of the participants falls within one standard deviation of the means achieved by Air Force trainees, Deignan, 1979).

In addition to the major implementation study, a series of three supplementary studies was also conducted in order to enhance future administrations of the learning strategy program. One of these studies focused on the improvement of

training via peer interaction (the pair learning study), the second involved examination of the processing of supplementary text materials (the headings/outline study) and the third was designed to assess the effects of auditory distractions on text processing (the distraction study). The impetus for these three studies arose from the findings of previous evaluations of the strategy components.

II. Overall Evaluation of the Strategy System: The Implementation Study

Due to the complexities of academic and technical learning a mutually supportive set of interactive strategies is required to maximize learning potential. To examine and capitalize on these interactions, students must be taught large portions of the strategy system. Unfortunately the time and student motivation required for training precludes exploring this system in the context of typical short-term experiments. Therefore, to provide an overall evaluation, the component strategies were included in a one-semester (14 weeks) learning strategies course. This 2-credit-hour course was offered to Texas Christian University undergraduates during the 1978 Fall Semester (2 hours of class time per week).

A. Design

To determine if the effectiveness of strategy training is influenced by the sequence of instruction, the participants in the learning strategies class were randomly assigned to two groups. One group (P/S) received primary strategy training during the first half of the semester and support training during the second half. The other group (S/P) received the opposite instructional sequence.

To provide an overall evaluation of the program, a control group was recruited from General Psychology classes. The major bases of comparisons between class subgroups and between the class and the control were scores on a series of tests over textbook material which had been studied five days earlier. These tests were given to the class members and the control group prior to the start of the course (the pretest), approximately halfway through the course (the midcourse test), and at the end of the course (the posttest). A supplementary assessment was also made by comparing the groups on self-report measures (e.g., the Test Anxiety Scale, Sarason, 1956) administered before and after the course (see Figure 3 for an overview of the schedule of activities).

Members of the control group recruited from General Psychology classes were not exposed to any treatments during the course of the experiment. The decision to use a no-treatment rather than placebo control group was based on prior research

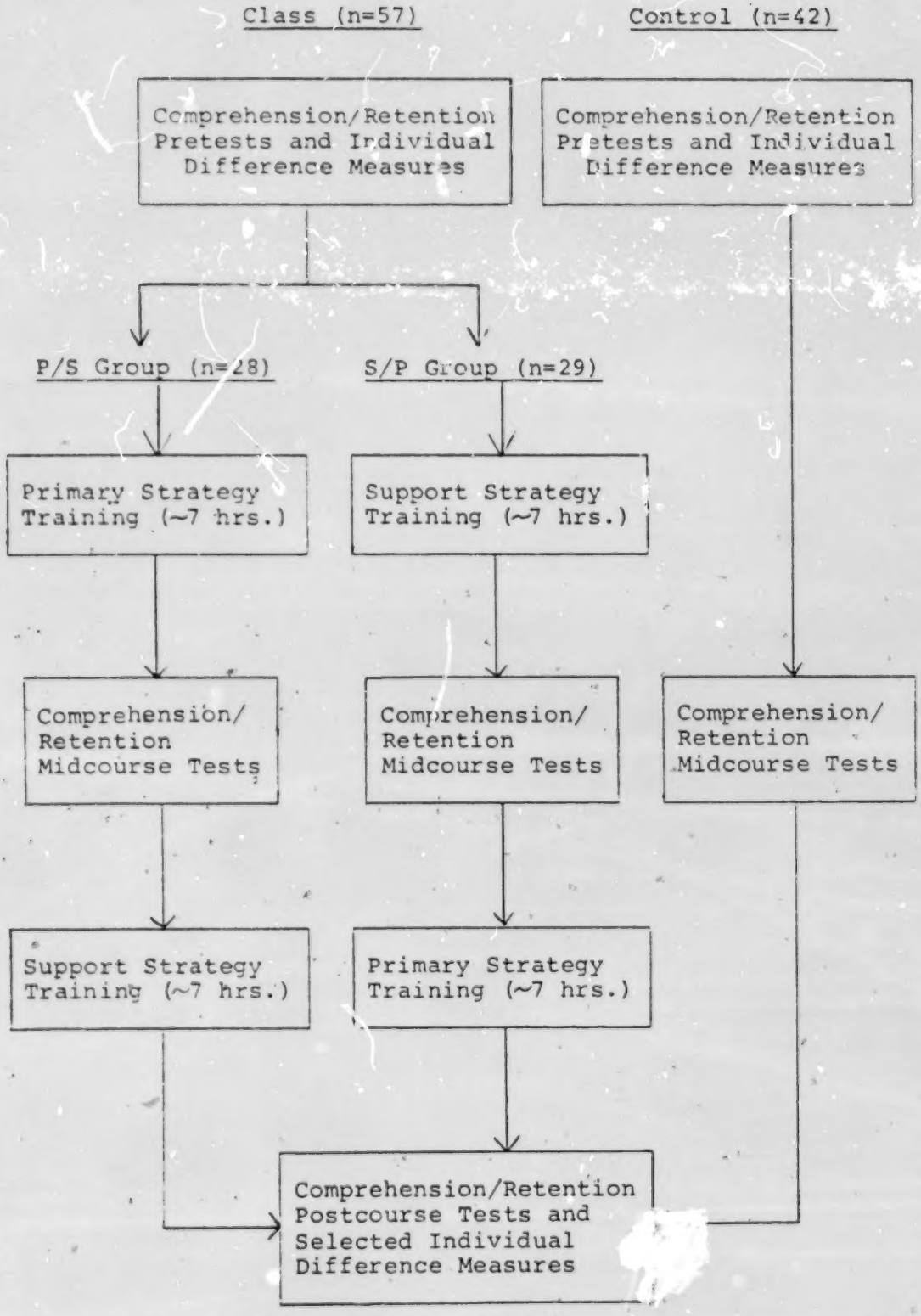

Class (n=57)
Control (n=42)
Comprehension/Retention Pretests and Individual Difference Measures
Comprehension/Retention Pretests and Individual Difference Measures
P/S Group (n=28)
S/P Group (n=29)
Primary Strategy Training (~7 hrs.)
Support Strategy Training (~7 hrs.)
Comprehension/ Retention Midcourse Tests
Comprehension/ Retention Midcourse Tests
Comprehension/ Retention Midcourse Tests
Support Strategy Training (~7 hrs.)
Primary Strategy Training (~7 hrs.)
Comprehension/Retention Postcourse Tests and Selected Individual Difference Measures

Figure 3. Training and Assessment Schedule for the Learning Strategies Course

with learning strategy training. Attempts at equating strategy training time by having students practice their own or less effective competing methods on the training materials have generally led to suppression of mean performance in comparison to "untrained" students using their own techniques (e.g., Collins, 1978; Garland, 1977; Long, 1976). Subjective reports from participants in these groups indicate that they do not view the placebo training as meaningful and consequently become frustrated and bored with the task. These reactions apparently carry over to the assessment phase, leading to the reduction in mean performance. It should also be emphasized that the college-age students participating in these experiments have had 12 to 14 years of experience and practice with their own study methods and can therefore be considered no-treatment controls in name only.

B. Method

1. Participants. The participants were Texas Christian University undergraduates, heterogeneous with respect to grade level, majors, sex, ethnicity, and academic aptitude.

The learning strategy class was composed of 57 students. A concerted effort was made to recruit students into this class who were similar in aptitude and interests to participants in military technical training programs. In particular, an attempt was made to attract students from the Harris College of Nursing (n=11) and students who were majoring in the sciences (n=32). The class was randomly divided into two groups: the P/S group which received primary training followed by support training (n=28) and the S/P group which received support training followed by primary training (n=29). The students received 2 semester hours of college credit for completing this course.

The control group consisted of 42 students who were recruited from General Psychology classes at Texas Christian University. (This is a basic course taken by a broad spectrum of students who are heterogeneous with respect to majors). After completing the experiment, they received credit for fulfilling an experimental participation requirement, a $12.00 fee, and a set of learning strategy materials. Interviews with members of the control group indicated that their prime motivation for participating was their interest in the learning strategy training materials. (This finding suggests substantial compatibility between the control group and the class. Further, a comparison of the profiles of the class and control groups indicated that they were very similar in terms of majors, grade levels, sex, and ethnicity. Of course, without complete random assignment the question of initial equality of groups is unresolved; consequently a pretest was administered to serve as a covariate for analyses of the mid-

course and postcourse tests (see Overall & Woodward, 1977a and b for a discussion of the appropriateness of this approach).

2. Experimental measures. Prior research at Texas Christian University has provided a large amount of data on three passages extracted from introductory textbooks. Each passage covers a different non-overlapping set of concepts. The specific content areas are: comprehension (educational psychology), plate tectonics (geology), and ecosystems (ecology).

These passages were selected in consultation with faculty experts. They were chosen, in part, because of the similarities of their content-independent properties (e.g., approximately the same length, 2400 to 2600 words; same number of author headings; same readability ratings, etc.). In addition, the content areas were chosen to ensure a minimal amount of direct prior knowledge on the part of the students. Pretest ratings obtained from participants in prior studies at Texas Christian University indicate that the majority have been previously exposed to less than 20% of the material presented in these passages.

The educational psychology text was employed as the premeasure and the geology and ecology passages were counterbalanced across the mid and post assessments. These latter two passages, which contained explanations and discussions of basic scientific theories, were considered to be analogous to some of the types of material presented in military technical training courses.

Five days after studying each of the passages the participants took a series of tests over the material: free recall essay, short-answer (13 questions), multiple-choice (36 questions) and concept cloze (24 questions; participants were required to fill in important concepts that had been deleted from selected sections of the text).

To provide supplementary information on the effectiveness of the program, the participants were also required to fill out a series of self-report measures before and after the course. These measures included: a 37-item Test Anxiety Scale (a modified version of the measure developed by Sarason, 1956), the 28-item Study Methods Utilization Inventory (a specially constructed scale designed to tap students' knowledge and use of effective learning and test-taking strategies), the 39-item Academic Skills Inventory (this measure, which asks the students to rate their ability on a number of academically-related dimensions, was a modification of a scale developed by Dansereau et al., 1979b; and the 16-item Academic Skills Satisfaction Scale (this scale, which was developed by the authors for use in this experiment, is designed to assess the level of satisfaction the students have with regard

to their learning and test-taking skills).

The Delta Vocabulary Test was also administered to all participants prior to the course. This 45-item, multiple-choice measure was developed by Deignan (1973). Previous research (e.g., Dansereau, 1978) has shown that this measure has moderately high correlations with other more time-consuming measures of verbal aptitude (e.g., Scholastic Aptitude Test scores). In addition, this measure has been shown to be moderately correlated (.50-.60) with performance on the primary dependent measures used in the present study. The Delta test was included in this experiment as a potential covariate and as a potential predictor of success in the strategy training program.

3. Procedure. During the first four 1-hour sessions, all participants were given an introduction to the nature of the study, filled out the self-report measures (Test Anxiety Scale, Study Methods Utilization Inventory, Academic Skills Inventory, and the Academic Skills Satisfaction Scale) and the Delta Vocabulary Test, and they studied and took tests (5 days after studying) over the comprehension passage. The class members were then randomly assigned to two groups (P/S and S/P). The P S group received approximately 7 hours (two 1-hour sessions per week) of distributed training and practice on the primary strategies while the S/P group received 7 hours of training and practice on the support strategies. Slightly modified versions of the self-instructional materials developed previously (see Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a) formed the basis of this training. To increase motivation, the students were allowed to practice the strategies on material from their regular courses. (Students were not allowed to practice the techniques on material related to the dependent measure passages).

Following this segment of training all participants (including the control group) studied and were tested over either the plate tectonics or ecosystems passage (approximately one-half of the participants from each group received the plate tectonics passage and one-half received the ecosystems passage). The testing occurred 5 days after studying. Following this assessment the P/S group received approximately 7 hours (two 1-hour sessions per week) of training and practice on the support strategies, while the S/P group received 7 hours of training and practice on the primary strategies. In both cases, the training materials and procedures were the same as employed in the first segment of the study.

All participants were then given the post-training assessment measures. The students studied and were tested over (5 days later) the passage that they had not encountered in the previous assessment (either plate tectonics or ecosys-

tems). They were also asked to respond to the four self-report measures (Test Anxiety Scale, Study Methods Utilization Inventory, Academic Skills Inventory and the Academic Skills Satisfaction Scale).

To provide a basis for an informal evaluation of the long-term effects of the strategy training, a 10-item questionnaire was mailed to all participating class members three months after the conclusion of the course.

C. Results

The results arising from analyses of the text processing tasks, self-report measures, and the follow-up questionnaire will be discussed separately in the following sub-sections.

1. Text processing tasks. All participants studied and took tests over text excerpts pretraining, midtraining, and posttraining. All tests were coded for "blind" scoring. The multiple-choice, short-answer, and concept cloze tests were scored according to predetermined keys, while the essay tests, which required the participants to summarize the text, were scored for completeness and organization by a graduate student not otherwise involved with the project (criteria for completeness and ideal organization were determined a priori). To assess reliability, a subset of the essay tests were independently scored by one of the authors. A Pearson product-moment correlation of .84 between the two sets of scores was judged to represent an adequate degree of interrater reliability. Raw scores were converted into percentages of the maximum possible on each test. Since each of the dependent measures had been modified via item analyses in previous studies, all items were retained for each test. Analyses of variance indicated that there were no significant passage effects or interactions on the midtests and posttests. Consequently, data from the two passages were collapsed for subsequent analyses.

A series of five, one-way analyses of covariance was run on the midcourse data. The single factor was groups (S/P vs. P/S vs. control), the dependent measures were the scores on the four tests, singly and in combination, and the covariates were Delta vocabulary scores and scores on the corresponding portions of the pretest (e.g., the short-answer scores on the pretest were used as covariates for the midcourse short-answer test). The adjusted means and standard deviations for the midcourse measures are presented in Table 1. Supplementary analyses showed that the assumption of regression slope equality across groups had not been violated. The results of the analyses of covariance indicated that there were no significant differences between groups on any of the measures.

Table 1

Means and Standard Deviations on the Mid Course Test (Following 7 Hours of Strategy Training) Adjusted for Delta Vocabulary and the Appropriate Pre Tests

Group	Essay		Short Answer		Multiple Choice		Cloze		Average	
	M	SD	M	SD	M	SD	M	SD	M	SD
P/S (n=26)	47.73	20.19	41.99	17.00	57.61	11.26	52.14	18.06	50.18	13.29
S/P (n=29)	48.14	21.16	41.54	15.80	60.23	11.22	58.06	15.88	51.62	12.21
Control (n=40)	52.12	24.15	36.69	17.65	62.78	11.05	55.26	15.04	51.79	12.53
	$F_{(2,90)}=.39$, N.S.		$F_{(2,90)}=.99$, N.S.		$F_{(2,90)}=1.62$, N.S.		$F_{(2,90)}=.87$, N.S.		$F_{(2,90)}=.13$, N.S.	

An identical set of analyses was run on the post data. The adjusted means and standard deviations are presented in Table 2. Once again supplementary analyses showed that the assumption of regression slope equality across groups had not been violated. The results of the analyses of covariance indicated that there were significant differences on the combined score ($F_{2,94}=4.85$, $p < .01$), the short-answer test ($F_{2,94}=3.97$, $p < .05$), and the essay test ($F_{2,94}=3.42$, $p < .05$). There were no significant differences on the concept cloze and multiple-choice tests. Tukey's post hoc comparisons indicated that the P/S group significantly outperformed ($p < .05$) the control group on all three tests found significant via the analyses of covariance. All other post hoc comparisons were non-significant. The percentages by which the P/S group outscored the control group on the various tests (adjusted means) are presented in Table 3.

2. Self-report measures. All participants responded to the following self-report measures pretraining and posttraining: the Test Anxiety Scale, Study Methods Utilization Inventory, Academic Skills Inventory and the Academic Skills Satisfaction Scale. The Test Anxiety Scale was scored according to preexisting keys to create a total score. The remaining three measures were submitted to item analyses in order to provide bases for the creation of homogeneous total scores on each measure. Total scores were created by summing items with item-total correlations above .30. A series of four, one-way analyses of covariance was run on the posttraining scores. The single factor was groups (S/P vs. P/S vs. Control), the dependent measures were the scores on the post administration of the four self-report instruments, and the covariates were the corresponding scores on the pre-administrations. The adjusted means and standard deviations for each post administration measure are presented in Table 4. In all cases, supplementary analyses indicated that the assumption of regression slope equality across groups had not been violated. The results of the analyses of covariance indicated that there were significant differences between groups on all four measures: (a) Test Anxiety Scale, $F_{2,91}=4.10$, $p < .02$; (b) Academic Skills Satisfaction Scale, $F_{2,95}=26.19$, $p < .001$; (c) Study Methods Utilization Inventory, $F_{2,91}=20.89$, $p < .001$; (d) Academic Skills Inventory, $F_{2,93}=13.81$, $p < .001$. Tukey's post hoc tests indicated the same pattern of results for the Study Method Utilization Inventory, Academic Skills Inventory and the Academic Skills Satisfaction Scale: the means of the P/S and the S/P groups were significantly better than those of the control group ($p < .05$) and were not significantly different from each other. The post hoc comparisons with the Test Anxiety Scale indicated that the only significant difference ($p < .05$) was between the S/P group and the control group (the S/P group reporting significantly less test anxiety than the control group).

Table 2

Means and Standard Deviations on the Post Course Test (Following 14 Hours of Strategy Training) for Delta Vocabulary and the Appropriate Pre Tests

	Essay		Short Answer		Multiple Choice		Cloze		Average	
	M	SD	M	SD	M	SD	M	SD	M	SD
P/S (n=28)	62.74	23.62	52.19	15.11	62.18	9.80	60.99	15.32	59.86	10.41
S/P (n=29)	60.23	18.65	46.89	14.45	63.85	10.52	58.94	12.52	56.94	9.64
Control (n=42)	49.73	22.51	41.05	17.38	60.95	10.81	54.41	15.41	51.68	11.90
	$F_{(2,94)}=3.42$, $p < .05$		$F_{(2,94)}=3.97$, $p < .05$		$F_{(2,94)}=.66$, N.S.		$F_{(2,94)}=1.78$, N.S.		$F_{(2,94)}=4.85$, $p < .01$	

Table 3

Percentage Amounts by Which the P/S Group Outperformed the Control Group on the Text Processing Measures

ESSAY	SHORT ANSWER	MULTIPLE CHOICE	CLOZE	AVERAGE
26.2%	27.1%	2.0%	12.1%	15.8%

Table 4

Adjusted (Pre-Training Scores Used as Covariates)

Post-Training Means and Standard Deviations*

for the Self-Report Measures

	Test Anxiety Scale**	Academic Skills Satisfaction Scale	Study Methods Utilization Inventory	Academic Skills Inventory
Primary/ Support	101.58 (25.52)	128.32 (11.61)	189.26 (27.57)	240.11 (22.56)
Support/ Primary	91.45 (18.88)	119.92 (12.32)	204.85 (34.81)	248.99 (27.77)
Control	104.78 (12.25)	106.77 (12.79)	163.07 (18.94)	223.09 (21.17)

*Standard Deviations are in parentheses.

**The lower the score the less the reported anxiety.

3. The follow-up questionnaire. This 10-item questionnaire was mailed to all participating class members three months after the conclusion of the course. Twenty-three of the twenty-eight members of the P/S group responded, while only thirteen of the twenty-nine members of the S/P group returned their questionnaires. The means and standard deviations for each of the questionnaire items are presented in Table 5. Inspection of this table indicates that the respondents felt that the training had a moderate to strong positive effect on the majority of the academic behaviors and outcomes surveyed by the questionnaire. Further, the P/S group reported consistently more positive outcomes than the S/P group. This latter finding parallels the results with the text processing tasks.

D. Discussion

The results of a series of analyses of covariance indicated that the participants given learning strategy training significantly outperformed untreated "controls" on selected text processing tasks, and also reported significantly more positive learning attitudes and behaviors on a set of self-report measures. Further, analyses of the text processing tasks and the follow-up questionnaire given to the "trained" group indicated that those who received the primary strategies prior to the support strategies benefitted more than those who received the strategies in the reverse sequence.

These findings will be discussed in more detail in the following subsections.

1. The text processing results. Significant differences on the post-training measures were observed with the combined scores, the essay scores and the short-answer test scores. The differences on the multiple-choice and concept cloze tests, although in the expected directions, did not reach significance. This differential effect of treatment on performance across the four test types is analogous to that observed in a previous evaluation of the training program (Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a). In the prior study, significance was found on a short answer test, but not on a multiple-choice test (only two tests were employed). The possibility that the multiple-choice and cloze measures are not sensitive enough to detect differences between groups can be substantially discounted. The results from related studies (Collins, Dansereau, Holley, Garland, & McDonald, 1979 and Holley, Dansereau, McDonald, Garland, & Collins, 1979) have shown significant effects on these measures due to strategy training.

In one sense the pattern of results observed in the present study is encouraging since short answer and essay tests

Table 5

Means and Standard Deviations* on the Items Included in a 3-Month Post-Training Questionnaire

	Primary/Support (n=23)	Support/Primary (n=13)
**What effect did the strategy training have on:		
(1) Your ability to understand textbooks	4.35 (1.95)	3.15 (1.99)
(2) Your ability to concentrate	5.13 (1.94)	4.92 (1.90)
(3) Your ability to take notes	4.35 (2.70)	4.31 (2.55)
(4) Your ability to take tests	5.22 (1.96)	4.62 (2.13)
(5) Your ability to write papers	3.87 (2.29)	2.54 (2.59)
(6) Your efficiency in studying	5.39 (1.91)	4.46 (2.17)
(7) Your ability to organize your thoughts	5.35 (2.20)	5.08 (1.98)
(8) Your grades	4.65 (2.10)	3.46 (1.87)
(9) Your attitude toward studying	4.96 (2.26)	4.00 (2.80)
(10) Your overall performance in college	5.30 (2.16)	4.46 (1.95)

*Standard deviations are in parentheses.

**Scale employed:

0	1	2	3	4	5	6	7	8
Had no effect at all		A small positive effect		A moderately positive effect		A strong positive effect		An extremely positive effect

are much less likely to be influenced by guessing and differential test-taking strategies than multiple-choice and fill-in-the-blank (cloze) tests. Since the training provided in this program did not emphasize academic test-taking techniques, the results are not totally unexpected.

The lack of significant differences on some measures and the consistent differences in performance between the S/P and P/S sub-groups strongly indicate that the positive findings observed on the postcourse tests are not due to placebo ("Hawthorne") factors (transitory increases in motivation due to treatment). Consequently, given that the present study replicates and extends previous strategy evaluations, the validity of the positive strategy effects on short answer and essay performance can be viewed with a great deal of confidence.

Within the treatment group, the P/S sub-group consistently outperformed the S/P sub-group on the text processing tasks. One possible explanation for this finding is that providing the students with effective primary strategies (comprehension/retention and retrieval) may alleviate motivational and concentration difficulties while the reverse effect may not occur with the support strategies. A second possibility is that the primary strategies require more time to master and that the members of the P/S group were able to practice these strategies over the entire duration of the program, while the S/P sub-group had only the second half of the program in which to master these techniques. Reports from the participants provided some support for both of these hypotheses; consequently, further research will be necessary to specify the factors influencing the observed training sequence effects.

2. Self-report results. The analyses of the adjusted postscores on the four self-report measures (Test Anxiety Scale, Study Methods Utilization Inventory, Academic Skills Satisfaction Scale, Academic Skills Inventory) generally indicated that the individuals who had received strategy training reported significantly more positive learning behaviors and attitudes than did the no-treatment controls. The fact that the strategy groups did not show significant changes on some of the items on these self-report scales reduces the possibility that the responses to the postmeasures were contaminated by artifactual "yea-saying."

With the exception of the Academic Skills Satisfaction Scale, the S/P group consistently exhibited more positive responses on the self-report measures. Since most of these measures included questions oriented toward attitudinal, motivational, and emotional assessment, it is not unexpected that the S/P group exhibited more positive means since they received training on improving these aspects of learning

(support strategies) at the beginning of the program and thus had a chance to practice these skills throughout the entire duration of the program. The P/S group received support training during the second half and, therefore, may not have had sufficient time to perfect these skills. This hypothesis is analogous to the one proposed in the previous section to partially explain the findings from the text processing tasks.

Although one must certainly be cautious in interpreting self-report data, it should be recognized that to some extent these measures can reflect a degree of "consumer satisfaction" with the training program. It can be argued that the student is in the best position to evaluate the present level of his or her skills and attitudes; consequently, self-reports should be considered as strong supplements to the more objective measures of performance. Synthesizing the results from objective and self-report measures provides convergence on the effectiveness of the treatment.

3. Follow-up results. The 10-item follow-up questionnaire mailed to the strategy participants 3 months after completion of the training indicated that the reported long-term effects of strategy instruction were positive. Further, it appeared that the P/S group viewed the effects more positively than the S/P group. This parallels the results with the text processing tasks.

The results with this questionnaire are particularly encouraging in that they suggest that the effects of learning strategy training are not transitory. Further, informal discussions with the participants following the administration of the questionnaire provided evidence that they were spending substantially less time studying due to increased efficiency in implementing the strategies.

E. Conclusions and Recommendations

The objective, self-report and follow-up assessments of the learning strategy training program indicate that the strategy training is successful in improving the effectiveness of students' learning behaviors and attitudes. These findings replicate and extend previous research with variants of this program (Dansereau, McDonald, Collins, Garland, Holley, Diekhoff, & Evans, 1979b). Although not formally evaluated, the improved effectiveness resulting from the strategy training should lead to increased efficiency (with a concomitant reduction in overall time for acquisition of new information) by reducing the need for re-learning and by providing a stronger knowledge base for the acquisition of new information.

Before permanent implementation of this program is undertaken, it is recommended that its cost-effectiveness be eval-

uated. Naturally the relative cost-effectiveness will vary across instructional situations; the present program will probably be most useful in situations involving long-term content courses (or course series) or in situations in which it is important to minimize the amount of retraining or field training necessary for successful job performance.

III. Supplementary Studies

We have completed three studies over the past year that have been designed to shed light on issues and questions arising from the development and evaluation of the learning strategy program. The results of these studies should facilitate future implementation of the program. The first study was designed to determine the effects of pair learning (two students interacting during the learning process) on the acquisition of content knowledge and strategy skills. If successful, this technique could be easily incorporated into the overall program as both a supplementary strategy and as a training technique. The second study was designed to examine the effects of section headings and outlines on the processing of text. The results from this study should improve the effectiveness of the primary strategies by providing guidelines as to how much emphasis a learner should place on the processing of headings and outlines. As a potential "spin-off," this study should provide information to designers of instructional materials concerning the importance of headings.

The purpose of the third experiment was to directly examine the effects of distracting noise during studying on specifiable sub-groups of students. The findings from this study should help tailor the support strategy training to individual needs.

Since these three studies were conducted in parallel with the previously reported implementation study, the findings have not been functionally incorporated into the strategy program. Suggestions for incorporation will be made during the discussion of each study.

A. The Pair Learning Study

The objective of this research was to investigate the effectiveness of a systematic pair learning strategy (a) on the initial acquisition of college-level textbook materials and (b) on the transfer of skills learned in a pair learning situation to individual learning.

Prior research has shown the use of pairs of students studying together to be effective in improving performance in academic and technical settings (Beaman, Diener, Fraser, & Endreson, 1977; Deignan, 1974a; Fraser, Beaman, Diener, &

Kelem, 1977; Schermerhorn, Goldschmid, & Shore, 1975). However, other research findings have suggested that while students studying in pairs or small groups learn more effectively than individuals, this increased effectiveness does not appear to transfer to individual learning tasks (Klausmeier, Wiersma, & Harris, 1963; Lemke, Randle, & Robertshaw, 1969).

In general, prior studies of pair learning have either focused on the review of previously learned materials or on fairly narrow tasks (i.e., concept attainment tasks) and have given only general instructions as to how students should interactively process the material. McDonald, Dansereau, Garland, Holley, and Collins (1978) developed a systematic pair learning strategy for initial acquisition of textbook material which was shown to be effective. This technique required students (a) to read two pages of material, (b) to recall (paraphrase) outloud from memory, (c) to re-read and discuss to check accuracy of recall, and (d) to ask each other experimenter-generated, content independent questions designed to broaden understanding of the material (e.g., "How would you improve the presentation of this material?"). McDonald et al., (1978) suggested that training on such a strategy would improve performance not only on tests over material studied in pairs but would also provide students with transferable skills to employ in individual learning. The present research was designed to explore this hypothesis. Three questions provided the focus for this study. (a) Is pair learning more effective than individual learning in initial acquisition of college textbook material? (b) Do students learn more effectively in a pair learning situation if they are given systematic instructions for pair interaction? (c) Does pair learning transfer to individual study?

1. Method. Students participating in the study consisted of 60 students recruited from General Psychology classes at Texas Christian University. Students received experimental credit for their participation and were paid a small fee.

Students were randomly assigned to three groups: (a) Group S, the system (formal) pair group, (b) Group N, the no-system (informal) pair group, and (c) Group I, the individual study group. Students in the two pair groups were randomly assigned learning partners. The strategy developed for the system pair group consisted of the following steps:

(1) Read for understanding.

(2) Recall from memory.

(3) Re-read to check accuracy of recall.

(4) Use a set of experimenter-provided questions designed to deepen understanding of the material.

Students in the no-system pair group were asked to decide on a method of pair learning; students in the individual group were instructed to use their normal study methods.

The study consisted of three sessions. In the first session, students in the system pair group were given training and practice on use of the technique with experimenter-provided text material. The students in the no-system pair group were instructed to practice on the same materials using the method of pair learning they had decided upon (e.g., reading the material and then informally discussing it). Students in the individual study group were instructed to employ their normal study methods on the practice material.

In the second session, the students read two 2,000-word passages and were told they would be tested on them in the third session. The students in the two pair groups studied the first passage (Ecology) in pairs and the individual study group studied alone. For the second passage (Geology), all students studied individually; the students in both pair groups were instructed to use their methods of pair learning on an individual basis. (All groups had the same amount of time to study each of the passages.)

The third session was the testing session. The students took essay, multiple-choice, cloze, and short-answer tests covering the material presented in the passages studied in Session Two. All students took the tests as individuals.

2. Results. A total score for each of the tests was created by summing the scores on the four subtests. An analysis of covariance was performed for both the Ecology and Geology tests, with grade point average used as the covariate. The results indicate that there were significant between-group differences for both the Ecology and Geology tests. After removal of the effects of the covariate, the Ecology test F ratio was 3.65 ($df=2,56$), $p < .03$; the F ratio for the Geology test, with the effects of the covariate removed was 3.39 ($df=2,56$), $p < .04$. Table 6 shows the composite means for the Ecology and Geology tests and the adjusted cell means for both tests with the effects of the covariate removed. (Supplementary analyses indicated that the homogeneity of regression slopes assumption had not been violated.)

In order to determine which groups differed significantly, a Tukey's HSD test (Kirk, 1968) for detection of group differences was performed. The results of this test for the Ecology test showed Groups S and N to be significantly different from Group I ($p < .01$, $p < .05$, respectively). The Geology test analysis showed Group S significantly outperformed Groups N and I ($p < .01$). All other differences between groups were non-significant.

Table 6

Means and Adjusted Cell Means (Effects of Covariate Removed) for Groups S, N, and I on Ecology and Geology Tests

	Ecology Test	
	Mean	Adjusted Mean With Covariate (GPA) Removed
Group S (System Pairs) (n=20)	36.25	36.59
Group N (No System Pairs) (n=20)	32.95	33.06
Group I (Individuals) (n=20)	29.20	28.75

	Geology Test	
	Mean	Adjusted Mean With Covariate (GPA) Removed
Group S (System Pairs) (n=20)	30.65	30.88
Group N (No System Pairs) (N=20)	24.85	24.92
Group I (Individuals) (n=20)	25.85	25.54

3. Discussion. In general, the results of this study suggest that pair learning is effective in initial acquisition of prose material whether or not students are given specific instructions for pair interaction. Further, the use of a systematic pair learning strategy leads to increased performance in a subsequent individual learning situation relative to the no-system (informal) pair group and the individual study group. This latter finding suggests that systematic pair learning may serve as an effective strategy training vehicle.

The implications for the learning strategy training program are clear. When feasible, pair learning can be used directly as a primary strategy. Further, the pair interaction situation appears to be very useful as a means for training more specific strategies and consequently deserves further examination.

B. The Heading/Outline Study

This study examined the utility of intact (i.e., topic outline format) and embedded (i.e., appropriately positioned within the text) headings as processing aids with non-narrative text. Headings potentially provide useful cues for both input and output processing but little empirical evidence exists to either support or refute this proposition. Each of the prior studies conducted in this domain (e.g., Glynn & DiVesta, 1977; Lee, 1965) is subject to one or more of the following criticisms which may attenuate the generality of the findings: (a) the employment of non-optimal dependent measures, (b) the use of short, artificial prose, (c) emphasis on immediate testing paradigms thus creating an implicit bias against the potential long-term benefits of headings, (d) lack of training on the use of headings as processing aids, and (e) failure to examine the effects of intact and embedded headings presented in combination.

The present investigation sought to respond to each of these sources of criticism. The specific objectives of the study were to examine the influence of headings as processing aids and training on the use of headings (both as input and output processing aids) with ecologically-oriented text under conditions of immediate and delayed recall; both intact and embedded headings were utilized in the investigation.

The principal manipulations of the paradigm employed in the study were represented by four experimental conditions (groups): (a) training on the use of headings as input cues (I/T; received stimulus passages with headings); (b) training on the use of headings as output cues (O/T; received stimulus passages with headings), (c) practice own study methods (H; received stimulus passages with headings), and (d) practice

own study methods (C; received stimulus passages with the headings deleted).

The hypotheses to be addressed by this paradigm were as follows:

1. Since the input role of headings may be limited by the prior knowledge of the students, the use of ecologically-oriented text might limit the effectiveness of headings on input. Consequently, it was expected that output training would result in better performance than training for input. Further, any advantages of output training would more likely be observed in the delayed testing condition.

2. The performance of students receiving training on the use of intact and embedded headings as processing strategies were expected to be superior to that of untrained students provided with headings.

3. Since the presence of intact and embedded headings was assumed to be a processing aid, it was expected that the performances of students receiving stimulus passages containing the headings would be superior to the performances of students whose passages did not contain the headings. Further, any advantages of headings as processing aids would more likely be observed in the delayed testing condition.

1. Method. Ninety-five students were recruited from General Psychology courses and randomly assigned to the four groups. The sample sizes were 23, 24, 22, and 21 for groups C, H, I/T, and O/T, respectively. (Five students failed to complete the experiment.) All students received 4 hours of experimental participation credit and a small fee.

The study consisted of four sessions:

Session 1 (120 minutes)

During this session students received a general introduction to the experiment and were asked to sign consent forms; these forms detailed the students' obligations in the experiment and acknowledged that the students were participating on a voluntary basis. Following this, students were randomly assigned to groups; members of each group were directed to designated classrooms and received folders containing practice materials and instructions corresponding to group assignment. Additionally, treatments and administrators were randomly assigned to groups and the administrators periodically rotated amongst groups to ameliorate any potential experimenter effects on the students. In all cases the practice sessions were paced by the experimenters.

The "training" groups' (Groups I/T and O/T) sessions consisted of the students reading the strategy instructions and then applying the technique to a practice passage similar in format to the passages to be encountered during the assessment sessions. (Input training required the students to write down their expectations based on an examination of the headings, while output training required the students to write down the information related to each heading following an initial reading.) Following this "study" period (20 minutes) the students were tested over the passage using the type of exam (i.e., free recall) to be employed as the dependent measure in the assessment sessions. The "no-training" groups' (Groups C and H) sessions were identical to those of the training groups with the exception that the students' instructions were to apply their "normal" study methods during the study session (see Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a; Holley, Dansereau, McDonald, Garland, & Collins, 1979; Holley & Dansereau, 1979, for elaboration of the no-training control procedure).

Session 2 (120 minutes)

Students spent 50 minutes studying a 2400 to 2500-word passage. Two passages were utilized: one extracted from an introductory biology textbook (Ecosystems) and one extracted from an introductory geology textbook (Plate Tectonics). One-half of the students (within each group) received the geology passage and the other one-half received the biology passage. After studying the passage, students spent 18 minutes responding to a free recall exam.

Session 3 (60 minutes)

Students spent 50 minutes studying and taking notes over the passage they had not been exposed to during Session 2.

Session 4 (60 minutes)

During this session, which occurred 5 days after the previous session, students responded to the free recall exam (18 minutes) for the "second" passage. All procedures were identical to those employed in Session 2.

2. Results. The analytic procedure consisted of a series of multiple discriminant analyses on the free recall measures at immediate and delayed testing. This series represented planned, orthogonal comparisons specifically designed to address the aforementioned hypotheses. Adoption of the multiple discriminant procedure was based on arguments presented by Harris (1975; pp. 16, 125-127) and Lana and Lubin (1970; p. 300) favoring a multivariate approach over a univariate, repeated measures procedure.

The series of analyses included the following ordered comparisons:

O/T versus I/T. This comparison was concerned with responding to the questions: Is one of the training methods more effective than the other? What is the nature of any between-group differences (e.g., immediate versus delayed testing)? If the groups are not discriminable they can be collapsed for subsequent analyses; if the groups are discriminable only the training group performing in a superior manner is of interest for subsequent analyses.

T versus H. Based on the outcome of the previous analysis, the training group was compared with the no-training group that received stimulus passages with headings, this comparison responded to the following questions. (a) Does training on the use of intact and embedded headings lead to improved performance? (b) What is the nature of any between-group differences (e.g., immediate versus delayed testing)? If the groups are not discriminable (i.e., training has no impact on performance), these groups can be merged for comparison against the control group; however, if the groups are discriminable (i.e., H > T), then only group H need be compared to the control group.

H/T versus C. Based on the outcome of the previous analysis the group receiving stimulus passages with headings (H and T collapsed) was compared to the group which received stimulus passages with the headings deleted. This comparison addressed the questions: Does the presence of intact and embedded headings lead to improved performance? What is the nature of any between-group differences (e.g., immediate versus delayed testing)?

All of the dependent measures were coded for blind scoring. The free recall exams were scored by a colleague not otherwise associated with the investigation and a random sample of these measures was independently scored by the author to assess interrater reliability. A Pearson product-moment correlation of .87 between the two sets of scores was judged to represent an adequate standard of interrater reliability.

Means and standard deviations for the free recall measures are reported in Table 7. The discriminant analysis between the two training groups on the free recall-information exams failed to produce a significant discriminant function ($\chi^2[2] = .79$, $p \leq .67$). This outcome indicated that the training groups could be collapsed for comparison against the no-training group that had received stimulus passages with headings. (See Table 8 for all of the discriminant equations developed for the free recall analyses.)

Table 7

Means and Standard Deviations on

the Free Recall Measures[a]

Group[b]		Free Recall Exam	
		Immediate	Delayed
Control (C) (n=23)	$\bar{x}$	40.58	24.90
	sd	14.13	14.07
Headings (H) (n=24)	$\bar{x}$	46.31	35.42
	sd	13.49	19.44
Input (I/T) Training (n=22)	$\bar{x}$	45.82	38.23
	sd	14.57	21.54
Output (O/T) Training (n=21)	$\bar{x}$	42.87	33.84
	sd	20.84	12.04

[a]Scores are reported in percentages of maximum possible score.

[b]See text for elaboration.

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Table 8

Discriminant Equation Weights

Developed for the Free Recall Analyses

Comparison[a]	Free Recall Exam		p ≤
	Immediate	Delayed	
O/T vs I/T	1.45	2.68	.67
T vs H	3.81	-1.72	1.00
T/H vs C	1.07	3.79	.04

[a] O/T vs I/T: Output training compared to input training.

T vs H: The collapsed training groups compared to the headings-without-training group.

T/H vs C: The collapsed headings-without-training group and headings-with-training groups compared to the no-headings-no-training group (i.e., presence of headings compared to absence of headings).

The discriminant analysis between the collapsed training groups (T) and headings-without-training group (H) also failed to produce a significant discriminant function ($\chi^2[2] = 0.00$, $p \leq 1.00$). This result suggested that training on the use of intact and embedded headings provided no improvement in performance over simply incorporating those cuing devices within the text; consequently, groups T and H were collapsed for comparison against the control group.

The equation contrasting group T/H against group C was significant ($\chi^2[2] = 6.70$, $p \leq .04$); the performance of the former group was superior to that of the latter group. The pattern of loadings suggested that the performance advantage attained by providing students with text containing intact and embedded headings was attributable primarily to increased recall of information in the delayed testing condition. The relative importance of the two testing conditions to the discriminant function was approximately 4:1 in favor of the delayed test. Additionally, students receiving stimulus passages containing intact and embedded headings recalled approximately 11 percent more information at immediate testing and 44 percent more information at delayed testing than students whose passages did not contain these processing aids.

3. Discussion. The results indicated that input and output training on the use of headings was ineffective in comparison with the group (H) that employed their "normal" study methods with the headings. However, this failure to find a facilitative effect of training should be interpreted cautiously since the negative findings may have been due to the limited amount of time the students had to integrate the new strategies with their existing techniques. Previous research on learning strategies training has indicated that both the amount of training and the time for integration may be important variables in such contexts (e.g., Dansereau et al., 1979a). Additionally, the training methods employed in the present study should be regarded more as providing the students with an instructional set for the input or output use of the headings rather than as providing the students with an intensive training program.

The results also indicated that students provided with text containing headings performed significantly better than students whose text did not contain these processing aids. The principal difference between the groups occurred in the delayed recall condition; students in the with-headings groups recalled approximately 11 percent more information at immediate recall and 44 percent more information at delayed recall than students in the without-headings group.

In general, the results of this study support the assumption that the presence of intact and embedded headings facili-

tates performance with non-narrative text, particularly at long-term delays. This outcome tentatively suggests that these devices may be more useful as retrieval aids than as comprehension aids. This interpretation may explain why some of the previous investigations exploring the utility of headings as comprehension aids with immediate testing conditions failed to find facilitative effects (e.g., Klare, Shuford, & Nichols, 1958; Robinson & Hall, 1941).

The pragmatic implications of the present study appear to be rather straightforward. Texts and training manuals should be constructed with intact and embedded headings and students should make extensive use of these devices for studying and test-taking. A post-experiment questionnaire revealed that the vast majority of participants in this experiment extensively use headings and outlines in their normal studying. However, this may not be true for other populations; in which case, training on strategies for using this information could prove beneficial.

C. The Distraction Study

The primary purpose of the present study was to evaluate the effects of task-irrelevant, conversational noise on the performance of simulated academic tasks. In previous research evaluating the effect of learning strategies on academic performance (Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979a) students reported that lack of concentration due to distractions is a primary deterrent to comprehension/retention of academic materials. One of the most common distractions reported by students was extraneous conversation. Thus, the present study attempted to address a seemingly critical aspect of student behavior not clearly addressed in previous research.

A secondary question addressed in the present study involved the evaluation of the effects of pre-training in the form of guided experience on performance under potentially distracting conditions (i.e., conversational noise). This training focused primarily on assisting students in developing an appropriate schema (plan) for learning under distraction conditions.

A number of individual difference measures (Delta Vocabulary Test, General Concentration Questionnaire, Rotter's Internal-External Locus of Control Scale [Rotter's I-E], Test Anxiety Scale, and Group Embedded Figures Test) were included in the present study to assess the relationship between student characteristics and performance of the simulated academic tasks. Performance was evaluated under both normal and potentially distracting conditions.

In review, the goals of the present study were as follows:

1. To assess the general effects of conversational noise on simulated academic performance. The previous research in this domain has been meager and the findings are equivocal. The present study was designed to be a first step in clarifying the important variables in this domain.

2. To determine if pre-training in the form of guided experience under potentially distracting conditions positively impacts on subsequent performance under similar conditions. Again, the previous literature on this topic is extremely limited.

3. To determine if there are specifiable subsets of students whose performance is differentially affected by conversational noise, and training in coping with such noise. The lack of attention to individual differences in the previous literature may be one of the predominant reasons for the equivocal results that have been reported.

To provide information on these questions, three groups were employed in this study:

GROUP 1: Guided Experience + Exposure to Noise Group

This group received training in the form of a guided experience in coping with the conversational noise to which they were exposed.

GROUP 2: Exposure to Noise Group

This group was exposed to exactly the same conditions of conversational noise to which Group 1 was exposed, but received no training.

GROUP 3: No Exposure to Noise Group

This group was treated almost identically to Group 2. The exception was that this group was not exposed to the conversational noise condition.

Comparisons between Groups 2 and 3 will provide information relevant to the first question. Comparisons between Groups 1 and 2 will provide data on the effects of training. Finally, interactions of Groups 2 and 3 with factors formed from the individual difference measures will provide information on experimental question three.

1. Method. Seventy-four students were recruited from General Psychology courses and randomly assigned to the three

groups. The sample sizes were 21, 20, and 24 for Groups 1, 2, and 3, respectively. (Nine students failed to complete the experiment.) All students received 4 hours of experimental participation credit and a small fee.

The experiment consisted of three sessions for each of the three groups.

GROUP 1: THE GUIDED EXPERIENCE + EXPOSURE TO NOISE GROUP

SESSION 1

Part I: Individual Difference Measures (20 minutes)

During the first session, this group was given two of the individual difference measures previously described. The sequence is presented below:

Delta Vocabulary Test (10 minutes)

General Concentration Questionnaire (10 minutes)

Part II: Training in Study Session 1 (85 minutes)

Following the administration of the individual difference measures, this group was given guided experiences in coping with distractions. The sequence is outlined below:

a. Students were given a brief rationale for the experience, and general instructions for the upcoming study session.

b. Students were instructed to:

(1) Read and study Article 1, a 2,000-word passage, for 40 minutes. (Half the group read Article A [extrapolated from an introductory biology text] and half read Article B [extrapolated from an introductory geology text].)

(2) While studying, attend to the methods used for coping with the conversational noise. (Developing coping strategies should take precedence over learning the material.)

c. Students began studying the article; the tape recording was played for the duration of their studying. The tape recording was meaningful, conversational noise maintained at 60 dB. The conversation was intermittent (Variable Interval: on 2 minutes; off 20 seconds).

d. Students were interrupted at 15 minutes and 40 minutes (end) into the study session and asked to evaluate how well they were learning the material, how well they were coping with distractions, and what coping methods they were employing. To

aid the students in developing strategies for coping, the options on the questionnaire they were requested to answer in order to evaluate the above contained examples of strategies the students could employ. For example, one option read, "Did you talk yourself out of listening to the tape recording?"

e. After studying, the students were asked to write down the coping methods they employed during the study session.

f. The students were asked to answer questions about how the coping methods used in this session might be used to cope with internal distractions and other forms of external distractions.

This session lasted 1 hour and 45 minutes.

SESSION 2

Part I: Individual Difference Measures (20 minutes)

During the second session, two individual difference measures were administered. The sequence is delineated below:

Rotter's Internal-External Scale	(10 minutes)
Test Anxiety Scale	(10 minutes)

Part II: Test Session 1 (40 minutes)

Following the administration of the individual difference measures, the group was given tests over Article 1 (either Article A or Article B) which was studied in the previous session. The sequence will be outlined below:

a. Free Recall Essay Test	(18 minutes)
b. Short Answer Test	(15 minutes)

Part III: Study Session 2 (45 minutes)

Following the testing, students were given a 5-minute break and were given the questionnaire they answered during Session 1. They were given 5 minutes to review this questionnaire and conceivably retrieve the schema or plan they developed in the previous session for coping with distractions.

Following a review of the questionnaire, students began studying Article 2 (Article A for the half of the students who previously studied Article A) for 40 minutes under conditions similar to those in which they studied Article 1 (i.e., conversational noise). The conversational noise was identical to that employed in the first study session.

The one difference between this study session and the previous one is that in this session students were not guided by the experimenter. They were expected to employ their previously developed coping techniques as their schema dictated.

This session lasted 1 hour and 45 minutes.

SESSION 3

Part I: Individual Difference Measures (12 minutes)

During the last session, the Group Embedded Figures Test was administered.

Part II: Test Session 2 (40 minutes)

In this last session students were required to take the free recall essay test (18 minutes) and short-answer test (15 minutes) over Article 2 (either Article A or Article B).

The third session lasted 52 minutes.

GROUP 2: EXPOSURE TO NOISE GROUP

SESSION 1

Part I: Individual Difference Measures (20 minutes)

This part of Session 1 was identical to that of the previous group.

Part II: Study Session 1 (85 minutes)

Following the administration of the individual difference measures, this group was given exposure to the conversational noise during a study session. The sequence is outlined below:

1. Students were given a rationale for the session and general instructions.

2. Students were instructed to read and study Article 1, a 2,000-word passage, for 40 minutes. (Half the group studied Article A and half studied Article B.)

3. Students were informed that they would be tested over the material in the next session.

4. Students studied under conditions of conversational noise identical to the conditions under which Group 1, the Guided Experience + Exposure to Noise Group, studied. (The students were not guided in any way.)

This session lasted 1 hour and 45 minutes.

SESSION 2

Part I and Part II: Identical to Group 1, the Guided Experience plus Exposure to Noise Group

Part III: Study Session 2 (45 minutes)

Students in this group were treated in the same manner as students in the Guided Experience + Exposure to Noise Group, except that this group received no direct training and thus did not review or implement an experimenter-guided schema technique.

This session lasted 1 hour and 45 minutes.

SESSION 3

This session was identical to the session described for the previous group.

This session lasted 52 minutes.

GROUP 3: NO EXPOSURE TO NOISE GROUP

SESSION 1

Part I: Identical to previous groups.

Part II: Study Session 1 (85 minutes)

Students studied Article 1 (either Article A or Article B) in the same manner as the other two groups with the following exceptions:

a. Students did not study under conversational noise.

b. Students did not receive any training.

SESSION 2

Part I and Part II: Identical to previous groups.

Part III: Study Session 2 (45 minutes)

Students studied Article 2 (either A or B) under conditions identical to those under which they studied Article 1.

This session lasted 1 hour and 45 minutes.

SESSION 3

Identical to previous groups.

The dependent measures for all groups consisted of a set of comprehension/retention tests for each of the two articles studied. Each set of tests consisted of a free recall essay test and a short-answer test.

The free recall essay test and short-answer test (13 questions) are very similar to tests typically administered in college and technical training courses. Previous research has found performance on these tests highly correlated with grade point average (Collins, 1978).

2. Results. All dependent measures were coded for blind scoring. The short-answer tests were scored according to a predetermined key. The free recall tests were scored by a colleague not associated with the design of the study.

Possible interactions between passages (Ecology or Plate Tectonics) and groups were checked by two-way analyses of variance and found to be non-significant. Therefore, in order to reduce within-cell variance, a constant was added to the Ecology test scores to equate the means of the Ecology and Plate Tectonics tests. In all subsequent analyses, scores on the Ecology tests, modified by the addition of the constant, and scores on the Plate Tectonics tests were collapsed. Thus scores for performance in Session 1 consisted of scores on tests over material studied in Session 1, whether the material was the Ecology passage or the Plate Tectonics passage. Further, due to the high correlation (.74) between the short-answer and free recall tests, scores on these two tests were summed to produce a total score for performance in a given session (either Session 1 or Session 2).

The statistical analyses conducted on the data were conducted with different sample sizes. When participants were eliminated to achieve equal sample sizes, participants were eliminated at random.

The results of the statistical analyses will be discussed in terms of the three experimental questions addressed in this study. The first experimental question involved the assessment of the effects of conversational noise on simulated academic performance. Comparisons between Groups 2 and 3 provide information relevant to this question.

The second question involved the effect of training. Comparisons between Groups 1 and 2 provide information on the effects of training.

The first step in making these comparisons involved the use of a series of one-way analyses of covariance (ANCOVA). The adjusting variable (covariate) used in these analyses consisted of scores on the Delta Vocabulary Test. The independent variable was group affiliation and the dependent variable consisted of the sum of scores on the short-answer and free recall tests.

Separate ANCOVAs were conducted for Session 1 and Session 2 since performance during these two sessions could potentially differ. The results of the ANCOVAs indicated no significant differences between the groups. (Means and standard deviations are presented in Table 9 and Table 10.)

The lack of significance suggests that neither training nor noise had an effect on performance. Potential explanations for these outcomes will be presented in the discussion section.

Information relevant to question 3 was provided by a comparison of Groups 2 and 3 in terms of possible interactions with scores on the individual difference measures. (Data provided by Group 1 were seen to be less pertinent due to potential confounding of noise and training effects.)

The first stage of investigation of the third question involved the use of a series of multiple regression analyses employing five predictor variables and one criterion variable. The predictor variables were Delta Vocabulary Test, Rotter I-E, Test Anxiety Scale, Group Embedded Figures Test, and the General Concentration Questionnaire. Single scores for each of the first four measures were created using pre-established keys. The scores on the General Concentration Questionnaire were created following an item analysis. Items with item-total correlations greater than .3 were summed to form a single total score. The criterion variable for the multiple regression analyses was a score representing the sum of scores on the two comprehension/retention tests (short-answer and free recall) for a given session.

The multiple regression analyses were conducted separately for Group 2 and Group 3 for Session 1 and Session 2. In all but one case, a significant proportion of variance (R^2) was explained by scores on the individual difference measures (see Table 11). The predictive power of specific individual difference measures differs, however, for Groups 2 and 3. For example, Rotter's I-E is negatively weighted for Group 2 and positively weighted for Group 3 (see Table 12).

To clarify the results of the multiple regression analyses, a series of two-way ANOVAs was conducted. For each of the ANOVAs, factor 1 was group affiliation (Group 2 versus Group 3).

Table 9

Unadjusted and Adjusted Means and Standard Deviations for the Three Groups on the Dependent Measures for Session 1

Group	Mean unadjusted (sd unadjusted)	Mean adjusted for covariate (sd adjusted)
1 Noise plus training (n=21)	27.66 (11.85)	28.01 (9.88)
2 Noise (n=20)	28.89 (9.36)	29.04 (8.82)
3 Control (n=24)	31.59 (16.35)	31.16 (12.97)

Table 10

Unadjusted and Adjusted Means and Standard Deviations for the Three Groups on the Dependent Measures for Session 2

Group	Mean unadjusted (sd unadjusted)	Mean adjusted for covariate (sd unadjusted)
1 Noise plus training (n=21)	29.63 (13.59)	29.99 (11.39)
2 Noise (n=20)	30.83 (11.07)	30.99 (8.17)
3 Control (n=24)	29.30 (14.05)	28.86 (11.68)

Table 11

Multiple Regression Analyses

for Individual Difference Measures

on Group 2 and Group 3

Variable	R^2	F
Group 2-Session 1	.316	2.75*
Group 2-Session 2	.446	4.06**
Group 3-Session 1	.475	5.17***
Group 3-Session 2	.464	4.98***

*$p \leq .06$

**$p \leq .05$

***$p \leq .005$

Table 12

Comparison of Beta Weights for Individual Difference Measures in Multiple Regression Analyses for Group 2 and Group 3

	Beta Weights				
	Delta	Rotter	TAS	GEFT	General Concentration
Group 2-Noise					
Session 1	.097	-.198	-.423	.435	-.11
Session 2	.416	-.183	-.22	.342	-.265
Group 3-Control					
Session 1	.151	.209	-.038	.375	.380
Session 2	-.180	.339	-.184	.674	.222

Factor 2 was created by using a high-low median split on scores for each of the particular individual difference measures. The dependent variable was, again, a score representing the sum of scores on the short-answer and free recall tests for a given session. Tukey's post hoc comparison procedure (Kirk, 1968) was conducted when appropriate. The results of these ANOVAs will be presented in the following sections, labeled according to the relevant individual difference measure.

Delta Vocabulary Test. A two-way ANOVA employing a high-low median split on scores on the Delta Vocabulary Test as Factor 2 indicated a significant difference between high and low Delta groups during Session 1, F (1,36) = 7.05, p = .011 and Session 2, F (1,36) = 10.71, p = .002. (Means and standard deviations are presented in Table 13.)

In both cases, the high Delta group outperformed the low Delta group. All other effects were non-significant.

Rotter's I-E. An ANOVA conducted with a high-low median split on the Rotter's I-E indicated a significant interaction, F (1,36) = 4.25, p = .044, for performance during session 1. A Tukey's post hoc comparison showed no significant differences between groups. This is seemingly due to the fact that this was a "crossing" (disordinal) interaction. This point will be elaborated in the discussion section.

For session 2, the interaction between factor 1 and factor 2 was also significant, F (1,36) = 4.276, p = .044. Again, Tukey's post hoc comparisons showed no significant differences between groups. (Means and standard deviations are presented in Table 14.) All other effects in both analyses were non-significant.

Group Embedded Figures Test. An ANOVA employing a high-low median split on scores on the GEFT indicated a significant difference between high-low GEFT groups in session 1, F (1,36) = 15.19, p = .001. As can be seen in Table 15, the high-GEFT group outperformed the low-GEFT group.

The interaction was also significant for session 1, F (1,36) = 6.31, p = .016. Tukey's post hoc comparisons showed that the difference between high-GEFT across the two groups ($p < .05$) was primarily responsible for the observed interaction. The group main effect was not significant.

Factor 2 was also significant for session 2, F (1,36) = 10.96, p = .002. Again, the high-GEFT group outperformed the low-GEFT group ($p < .05$). All other effects were non-significant. (Means and standard deviations are presented in Table 15.)

Table 13

Means and Standard Deviations for the High-Low Delta Groups on the Dependent Measures for Session 1 and Session 2

	Session 1		Session 2	
	High Delta	Low Delta	High Delta	Low Delta
Group 2-Noise				
$\bar{x}$	31.68	26.10	35.97	25.70
sd	(7.17)	(10.41)	(10.01)	(9.60)
Group 3-Control				
$\bar{x}$	41.50	26.52	38.60	24.73
sd	(15.66)	(11.60)	(13.72)	(10.45)

Table 14

Means and Standard Deviations for the High-Low Rotter Groups on the Dependent Measures for Session 1 and Session 2

	Session 1		Session 2	
	High Rotter (External)	Low Rotter (Internal)	High Rotter (External)	Low Rotter (Internal)
Group 2-Noise				
$\bar{x}$	26.10	31.68	27.90	33.77
sd	(7.31)	(10.32)	(9.38)	(11.83)
Group 3-Control				
$\bar{x}$	39.57	28.45	36.93	26.40
sd	(14.21)	(15.11)	(13.52)	(12.47)

Table 15

Means and Standard Deviations for the High-Low GEFT Groups on the Dependent Measures for Session 1 and Session 2

	Session 1		Session 2	
	High GEFT (Field Independent)	Low GEFT (Field Dependent)	High GEFT (Field Independent)	Low GEFT (Field Dependent)
Group 2-Noise				
$\bar{x}$	31.25	26.53	34.95	26.72
sd	(7.43)	(10.44)	(11.45)	(8.96)
Group 3-Control				
$\bar{x}$	44.93	23.09	39.62	23.71
sd	(11.68)	(10.82)	(12.11)	(10.97)

Test Anxiety Scale. ANOVAs using a high-low median split on the TAS indicated no significant differences between groups during session 1 and during session 2.

General Concentration Questionnaire. ANOVAs using a high-low median split on the General Concentration Questionnaire indicated no significant differences between groups during session 1 and during session 2.

3. Discussion. The results of this study will be discussed in terms of the following topics: the general effects of noise and coping training, the relationships of individual differences to performance in noise and non-noise situations, and the implications of the present research findings for future research and educational practices.

The lack of significant differences between the three groups in performance on the simulated academic measures employed in this study, although congruent with findings in previous research (Weinstein & Weinstein, 1979; Zimmer & Brachulis-Raymond, 1978), was unexpected. The present study was designed to maximize the potential effects of noise within an ecologically valid setting (i.e., typical academic tasks). The conversational noise used in this experiment was created to possess characteristics which students report to be major contributors to the potency of typical distractions (e.g., variability in volume and content, and high interest value). Subjective reports from the participants supported the contention that the noise employed in the present study had face validity (i.e., it was quite similar to typical distractions encountered by students).

Since it would seem that the noise did serve as a distraction, a second question concerns the adequacy of the dependent measures. The academic tasks were selected for their discriminative power. These measures have been shown to discriminate among treatment manipulations in a number of previous studies (e.g., Dansereau et al., 1979a; Collins, 1978). Consequently, the lack of significance in the present study would not seem to be attributable to insensitivity of the dependent measures.

What, then, is the explanation for the present findings? One possibility is that the noise used in this study did not include all of the characteristics necessary to make it a potent distraction. Although the noise was carefully selected, the constraints of the research setting were such that the noise was not personally relevant to each student (i.e., the recorded conversations did not concern the students themselves, or people they knew, nor did the events discussed have direct relevance for the students' daily lives). It is possible that this type of relevance is necessary for extraneous conversation

to be a potent distractor. Support for this may be seen in shadowing experiments in which a person's attention may switch from one channel to a previously unattended channel if the latter presents information of specific relevance--such as the name of the listener (Lindsay & Norman, 1972). One direction for future research would seem to be the exploration of effects of personally relevant versus personally irrelevant conversational noise on the performance of academic tasks.

A second possible explanation for the lack of overall significant differences is that the noise may have been suppressing the performance of some students and enhancing (perhaps by increased arousal) the performance of others. Thus, the overall performance level may have been the result of the "averaging" of two substantially different effects. The next few paragraphs will address this issue in more detail.

The relationship between internality-externality, as measured by Rotter's I-E scale, and performance under noise and non-noise conditions (see the Results section) supports the possibility of an "averaging" of noise effects, mentioned in the previous section. Under noise conditions, internals outperformed externals, whereas under non-noise conditions, externals outperformed internals (see Table 14). This finding replicates and extends the results reported by Dansereau, Long, McDonald, Actkinson, Ellis, Collins, Williams and Evans (1975b) One possible explanation for the finding is that externals tend to "give up" under the more difficult noise condition, whereas internals view the situation as under their control, and possibly evan a "challenge." This hypothesis seems consonant with Rotter's (1966) original conception of differences between internals' and externals' perceptions of control.

The idea that noise may differentially affect specifiable subgroups of students holds implications for the effect of the coping training given to Group 1. It is possible that some of the students (e.g., externals) did benefit from training whereas others were unaffected because the noise was not detrimental to their performance and thus, they had no need for coping strategies. Although formal analyses of data relevant to this issue are precluded due to the confounding of training and performance, examination of the means presented in Table 16 indicates that externals in the training group (Group 1) improved their performance under noise, relative to the internals, from session 1 to session 2, slightly more than the externals in the exposure to noise group (Group 2) and in the no-noise group (Group 3). Although these mean differences should be viewed with considerable caution, they do provide the basis for the formulation of hypotheses for future research.

In addition to the findings of differential performance of internals and externals, significant main effects were

Table 16

Means for High-Low Rotter Groups on the Dependent Measures for Session 1 and Session 2

	Session 1		Session 2	
	High Rotter (External)	Low Rotter (Internal)	High Rotter (External)	Low Rotter (Internal)
Group 1-Noise plus Training				
$\bar{x}$	25.6	30.0	28.5	30.7
Group 2-Noise				
$\bar{x}$	26.10	31.68	27.90	33.77
Group 3-Control				
$\bar{x}$	39.57	28.45	36.93	26.40

found with the high-low median split on the Delta Vocabulary Test and GEFT (see Results). The findings concerning the Delta are not surprising and replicate results found in previous studies (e.g., Dansereau et al., 1979a). The findings related to the GEFT are somewhat surprising in that embedded figures tests have been shown to be only minimally related to the verbal-comprehension and attention factors on the Wechsler test and other tests of simple verbal ability (Deignan, 1974b; Deignan & Duncan, 1973; Deignan, Seager, Kimball, & Horowitz, 1979; McCoombs, Deignan, & Siering, 1975; Witkin, Oltman, Raskin, & Karp, 1971). One possible reason for this conflict may be the use of longer passages in the present study. The length of these passages as compared to those typically used in the standard tests (usually < 500 words), may have placed more of a premium on the student's ability to disembed the important concepts and ideas from the supporting information. This ability is presumably possessed to a greater degree by field independent individuals. In terms of the available literature, the present study seems to be the first research which has shown a direct relationship between field independence-dependence and the text processing necessary for the performance on typical academic tasks. Successful replication of this finding will greatly extend the potential usefulness of the GEFT in educational settings.

The results of the present study raise a number of questions. (a) Is the degree of personal relevance of the noise an important contributor to its potency as a distractor? (b) Under what conditions does noise facilitate performance of academic tasks, and under what conditions does it degrade performance? (The present study has pointed to the importance of certain individual difference measures such as Rotter's I-E scale.) (c) Is training in coping with noise differentially effective for specifiable subsets of students, and can training resolve the differences observed in the text processing of field-independent and dependent individuals? Answers to these questions would seem to be a next step in clarifying the effects of noise on academic and technical performance.

Applications of the findings from this study to educational and technical training settings may be possible if the present findings concerning the performance of internals versus externals under noise and non-noise conditions are replicated in future studies. It would seem that Rotter's I-E scale could serve as a basis for assigning individuals to appropriate educational and work environments. Internals may prosper in relatively noisy environments (e.g., open classrooms) whereas externals may require conditions which minimize task-irrelevant stimuli. In addition, future learning strategy training administrators should probably increase the amount of "support" training given to externals in order to reduce their distractibility in noisy environments.

IV. Concluding Comments

This report represents the last in a series of reports on the learning strategy project conducted at Texas Christian University. The purpose of this project was to develop and assess cognitively based strategies designed to assist learners in acquiring and using academic and technical information. The premise has been that providing students with effective and efficient learning strategies will reduce educational costs, will improve the transfer of knowledge and skills to work environments and will allow students to adapt to less than optimal instructional situations.

The success of this project is evident on a number of levels. First and most important, an effective, 15-hour training program has been created and assessed. The program is sufficiently content independent to be applicable in a wide variety of instructional environments. Further, the basic components of the program, as well as a number of supplementary components, have been subjected to independent evaluations. These evaluations have indicated that the separate components could be profitably used in isolation to remediate specific learning deficiencies. More specifically, a number of primary and support components have led to 30-40% improvement in performance in comparison to students using their own learning methods.

The results from the strategy development and evaluation studies have been widely disseminated via journal articles, presentation at national and regional conventions, book chapters, technical reports, and personal communications. In this dissemination process the approaches and findings resulting from this project have been reviewed by numerous professionals in psychology and education. The positive reactions arising from these reviews provide consensual validation for the efficacy of the research that has been conducted. Finally, this project has stimulated "spin-off" projects by independent researchers in a number of universities and research organizations.

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